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Relative impacts of climate and land use changes on future flood damage along River Meuse in Wallonia

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Climate change is expected to increase flood hazard across most of Europe, both in terms of peak discharge intensity and frequency. Consequently, managing flood risk will remain an issue of primary importance for decades to come. Flood risk depends on territories' flood hazard and vulnerability. Beside climate change, land use evolution is thus a key influencing factor on flood risk. The aim of this research is to quantify the relative influence of climate and land use changes on flood damage evolution during the 21^{st} century. The study focuses on River Meuse in Wallonia for a 100-year flood.

A scenario-based approach was used to model land use evolution. Nine urbanization scenarios for 2100 were developed: three of them assume a "current tend" land use evolution, characterized by urban sprawl, while six others assume a sustainable spatial planning, leading to an increase in density of residential areas as well as an increase in urban functions diversity.

A study commissioned by the EU has estimated a 30 % increase in the 100-year discharge for River Meuse by the year 2100. Inundation modeling was conducted for the present day 100-year flood (HQ_{100}) and for a discharge HQ_{100} + 30%, using the model Wolf 2D and a 5m grid resolution Digital Elevation Model (Ernst et al. 2009). Based on five different damage curves related to land use categories, the relative damage was deduced from the computed inundation maps. Finally, specific prices were associated to each land use category and allowed assessing absolute damages, which were subsequently aggregated to obtain a damage value for each of the 19 municipalities crossed by River Meuse.

Results show that flood damage is estimated to increase by 540 to 630 % between 2009 and 2100, reaching 2.1 to 2.4 billion Euros in 2100. These increases mainly involve municipalities downstream of a point where the floodplain width becomes significantly larger. The city of Liège, which is protected against a 100-year flood in the present situation, would undergo about 450 million Euros damage for a 100-year flood in the 2100, i.e. in-between 21% and 25 % of the whole damage increase. The influence of climate is three to eight times higher than the effect of land use change according to the land use evolution scenarios considered. Nevertheless, these two factors have a comparable influence on seven municipalities. Consequently, although a careful spatial planning would not considerably reduce the overall flood damage at the level of the Walloon part of the Meuse Valley, more sustainable spatial planning could efficiently reduce future flood damage at the level of several most critical municipalities.

Reference

Ernst, J, Dewals, B, Detrembleur, S, Archambeau, P, Erpicum, S, & Pirotton, M. (2010). Micro-scale flood risk analysis based on detailed 2D hydraulic modelling and high resolution geographic data. *Natural Hazards*, **55**(2), 181-209.